application is as a bed topping material which is intended to keep material within a bed confined with limited ability to be entrained in a gas flow or to be caused to move around by such a flow. Such entrainment or abrasion typically causes significant losses to the material in the bed.

[0003] Ceramic packing elements can be produced by an extrusion or a dry-pressing process and hence have an essentially uniform cross-section along one axial direction which provides an axis of symmetry for the element. Several such shapes have been described in the art ranging from the very simple to the complex. All are based on an essentially cylindrical shape and differ basically in the internal structure within the cylindrical shape. The simplest structure is a basic cylinder with no internal structure at all. This type of structure is often called a Raschig ring and has been known for many years. At the other end of the complexity scale are the structures described in US Design Patent 455,029 and US Pat. No. 6,007,915. Between the extremes there are simple wagon-wheel shapes such as are described in US Pat. Nos. 3,907,710 and 4,510,263. Others show deformed cylindrical structures, such as those described in US Pat No. 5,304,423. BE 481 212 discloses a packing element for use in heat exchangers, distillation towers, catalyst supports, and the like having four through passages and an indented exterior surface. DE 24 25 058 discloses a ceramic filling material with a cylindrical or hexagonal shape and multiple through passages. US Pat. No. 2,172,714 discloses a stackable block for regenerators.

[0004] For certain applications, such as bed limiters, the pressure drop is less important since the thickness of the bed limiter layer is relatively small. It is far more important that the packing elements do not nest together and still allow free passage of gases while being heavier that the elements comprising the bed on which the packing elements rest and whose extent is thereby limited.

SUMMARY OF THE INVENTION

[0005] In accordance with one aspect of the present invention, a ceramic packing element is provided. The element has an essentially uniform cross-section along an axis passing through a center of the element and about which the element is symmetrical defining a length of the element. A ratio of a width

to the length is from 1.5:1 to 5:1. First and second concave external surfaces are provided at the ends of height and width axes respectively, perpendicular to the length direction. The concave surfaces are connected by surfaces that are selected from (i) convex surfaces and (ii) convex surfaces connected to the concave surfaces by relatively short intermediate flat surfaces. The element is provided with at least three through passages in the length direction. At least one of the passageways is kidney bean-shaped in cross-section. The kidney-bean shaped passageway has two generally parallel arcuate surfaces.

[0006] In accordance with another aspect of the invention, a method of forming a bed of packing elements is provided. The method includes extruding a mixture comprising one or more ceramic-forming components, sectioning the extruded mixture to form sections, firing the sections to form packing elements. Each of the packing elements has first and second concave external surfaces at the ends of height and width axes respectively perpendicular to a length direction. The concave surfaces are connected by surfaces that are selected from convex surfaces and convex surfaces connected to the concave surfaces by relatively short intermediate flat surfaces. The element is provided with at least three through passages in the length direction. At least one of the passageways is kidney bean-shaped in cross-section. The kidney-bean shaped passageway has two generally parallel arcuate surfaces. The method further includes assembling a bed of packing elements including a plurality of the fired packing elements.

[0007] In accordance with yet another aspect of the present invention, a ceramic packing element is provided. The element has first and second opposed generally planar surfaces. First and second concave external surfaces are provided at the ends of height and width axes, respectively, of the planar surfaces. The concave surfaces are connected by surfaces that are selected from (i) convex surfaces and (ii) convex surfaces connected to the concave surfaces by relatively short intermediate flat surfaces. The element is provided with a plurality of through passages in a length direction, at least one of the through passages having a cross section defined by a first arcuate surface and a second arcuate surface, the second arcuate surface being longer than the first arcuate surface and located generally parallel thereto.

What is claimed is:

1. A ceramic packing element (1, 6, 8) having an essentially uniform cross-section along an axis (*l*) passing through a center (C) of the element and about which the element is symmetrical defining a length (L) of the element, and characterized by:

a ratio of a width dimension (W) to the length (L) being from 1.5:1 to 5:1, and first and second concave external surfaces (2, 3) at the ends of height and width axes (*h, w*) respectively perpendicular to the length direction, said concave surfaces being connected by surfaces that are selected from convex surfaces (4) and convex surfaces (4) connected to the concave surfaces by relatively short intermediate flat surfaces (7), and the element being provided with at least three through passages (5) in the length direction, at least one of the passageways (5e) being kidney bean-shaped in cross-section, the kidney-bean shaped passageway having two generally parallel arcuate surfaces.

2. An element (1, 8) according to claim 1 in which the concave surfaces (2, 3) are connected directly to convex surfaces (4).

3. An element (1, 6, 8) according to Claim 1 or 2 in which width and height dimensions (W, H) of the element are unequal with the ratio of width to height being from 1.25:1 to 3:1.

4. An element (1, 6, 8) according to Claim 3 in which width and height dimensions (W, H) of the element are in a ratio of from about 1.3:1 to 2.0:1.

5. An element (1, 6, 8) according to any one of Claims 1-4 in which the element is provided with from 3 to 275 passageways.

6. An element (1, 6, 8) according to any one of Claims 1-5 in which at least a plurality of the passageways (5a, 5b, 5c, 5d) are round in cross-section and a diameter (D) of each round passage is less than about one half of the height (H) of the element.

7. An element **(1, 6)** according to Claim 6 in which the plurality of passageways **(5a, 5b, 5c, 5d)** have identical dimensions.

8. An element **(8)** according to any one of Claims 1 to 7 in which the at least one kidney bean-shaped passageway **(5e)** has a largest dimension **(D)** which is up to about 2/3 of the height **(H)** of the element.

9. An element **(1, 6, 8)** according to any one of Claims 1 to 8 in which a total cross-sectional area of the passages represents from 20 to 75% of the total cross-sectional area of the element.

10. An element **(1, 6, 8)** according to Claim 9 in which a total cross-sectional area of the passages represents from 30 to 67% of the total cross-sectional area of the element.

11. An element **(1, 6, 8)** according to any one of Claims 1 to 10 in which the ceramic is a porous material.

12. An element **(8)** according to any one of Claims 1 to 11 in which the passages include a plurality of second passages **(5a, 5c, 5d)** having a second shape, the at least one kidney bean-shaped passage being positioned intermediate at least one of the plurality of second of passages and the center of the element.

13. An element **(1, 6, 8)** according to any one of Claims 1 to 12 in which a ratio of height to width of the element, H:L is from about 5:1 to 15:1.

14. An element **(8)** according to Claim 13 in which H:L is about 8:1.

15. A method of forming a bed of packing elements comprising:

extruding a mixture comprising one or more ceramic-forming components;

sectioning the extruded mixture to form sections;

firing the sections to form packing elements **(1, 6, 8)**, wherein each of the packing elements is characterized by first and second

concave external surfaces (2, 3) at the ends of height and width axes (*h, w*) respectively perpendicular to a length direction (L), said concave surfaces being connected by surfaces that are selected from convex surfaces (4) and convex surfaces (4) connected to the concave surfaces by relatively short intermediate flat surfaces (7), a ratio of a width dimension (W) to the length (L) being from 1.5:1 to 5:1, and the element being provided with at least three through passages (5) in the length direction, at least one of the passageways (5e) being kidney bean-shaped in cross-section, the kidney-bean shaped passageway having two generally parallel arcuate surfaces;

assembling a bed of packing elements which includes a plurality of the fired packing elements.